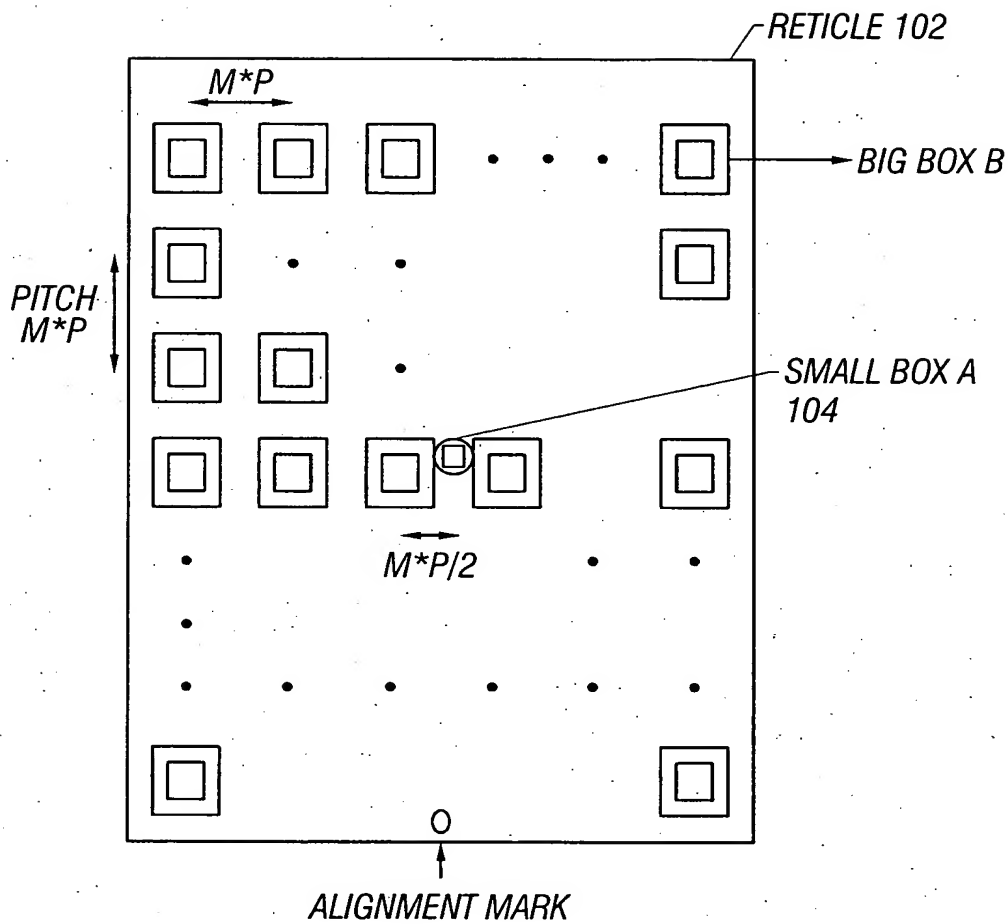




**Reticle schematic**

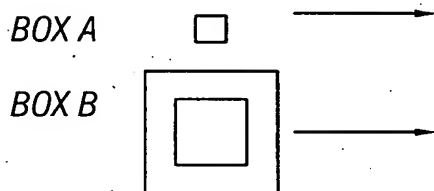


**FIG. 1**



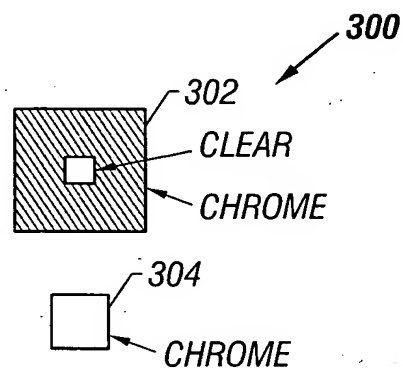
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**Schematics for FIG. 1**



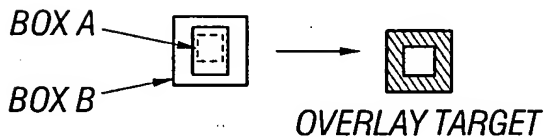
**FIG. 2**

**Reticle Features**



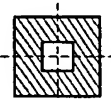
**FIG. 3**

**Overlapping regions**



**FIG. 4**

**Perfectly centered  
Box-in-Box structure**



**FIG. 4A**



Schematic for outer box 2



FIG. 5

Outer box 2 as printed on wafer.  
 Dark = unexposed, white = exposed



FIG. 6

Inner box 1 as printed on wafer.  
 Dark = unexposed, white = exposed

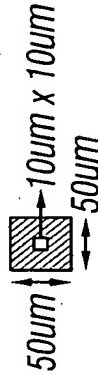


FIG. 8

Schematic for inner box 1



FIG. 7

Schematic for 2-dimensional 4XOL reticle

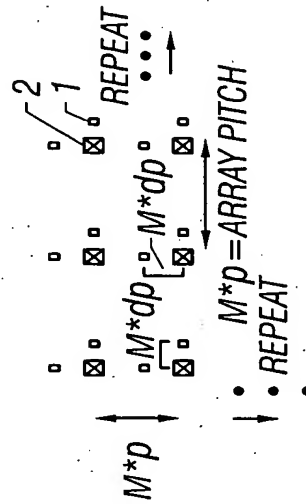


FIG. 9

Typical 4XOL reticle overlay set as projected  
 onto wafer (3 featured parts); dark = unexposed,  
 white = exposed

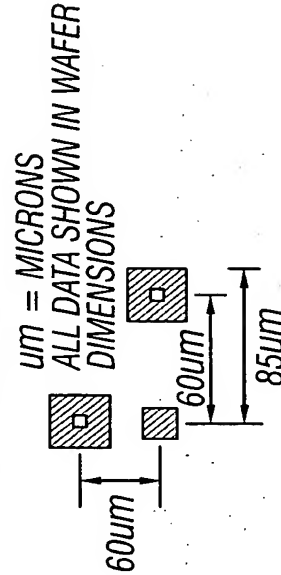


FIG. 10



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### Schematic of X-shear overlay on wafer

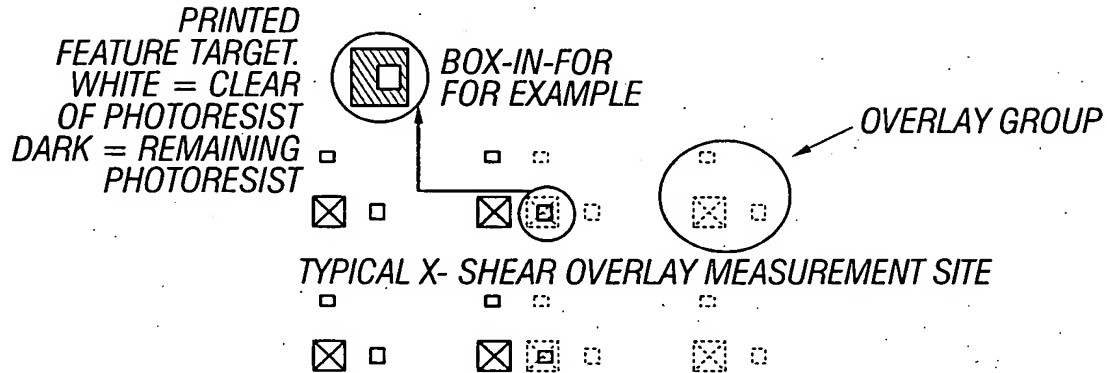


FIG. 11

### Schematic of Y-shear overlay on wafer

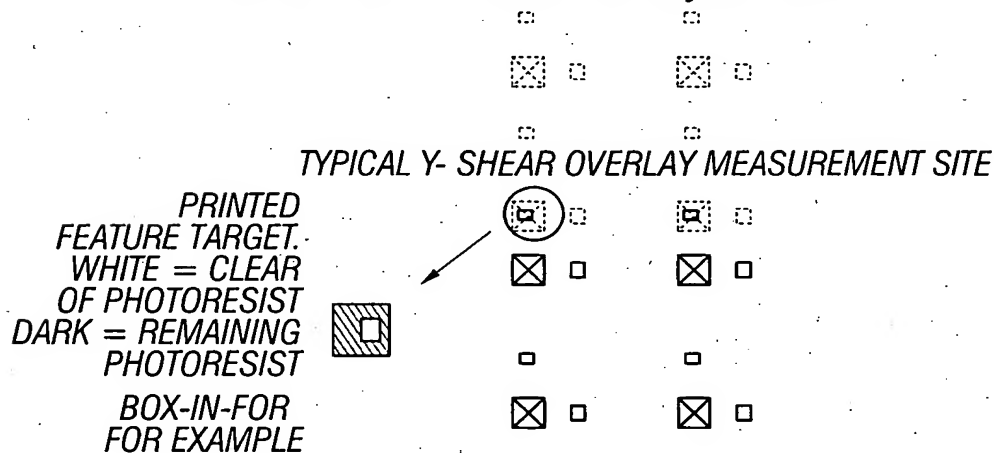


FIG. 12

### 2-Dimensional reticle schematic, 90 degree overlay or R-shear.

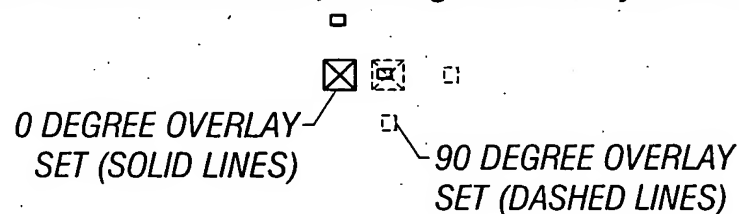
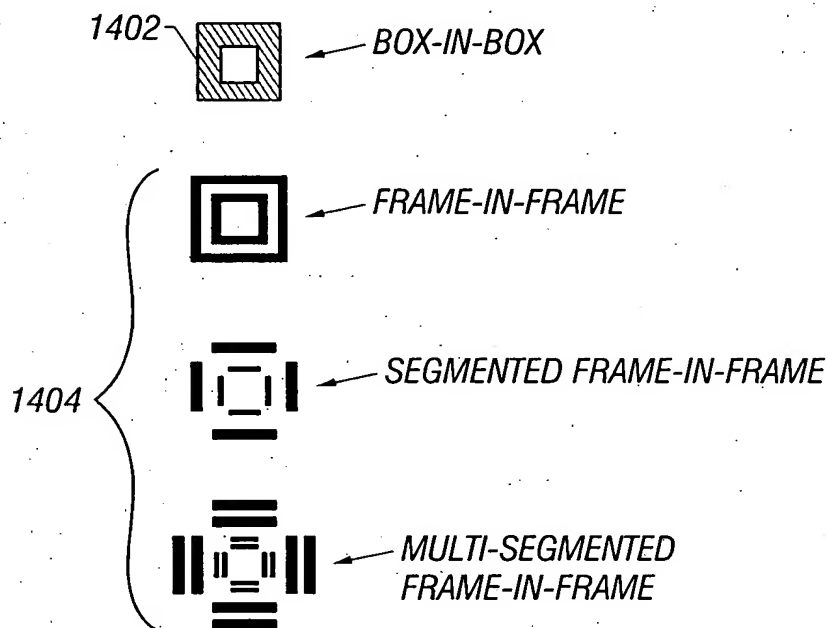


FIG. 13



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***Typical overlay patterns or completed alignment attributes***

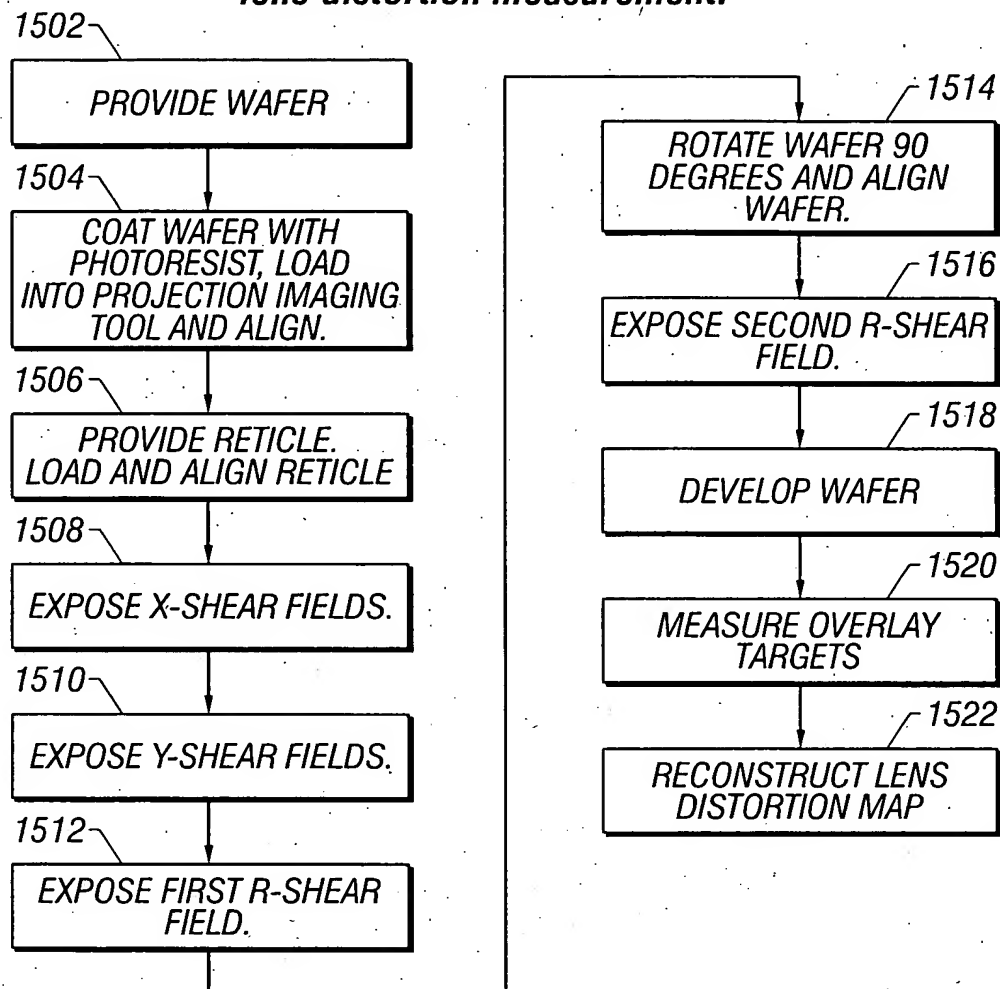


**FIG. 14**



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**Process-flow for the second embodiment for self-referencing lens distortion measurement.**



**FIG. 15**

**Some components of overlay or placement error  
(Inter-field and Intra-field)**



**FIG. 16**



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### Photolithographic stepper or scanner system

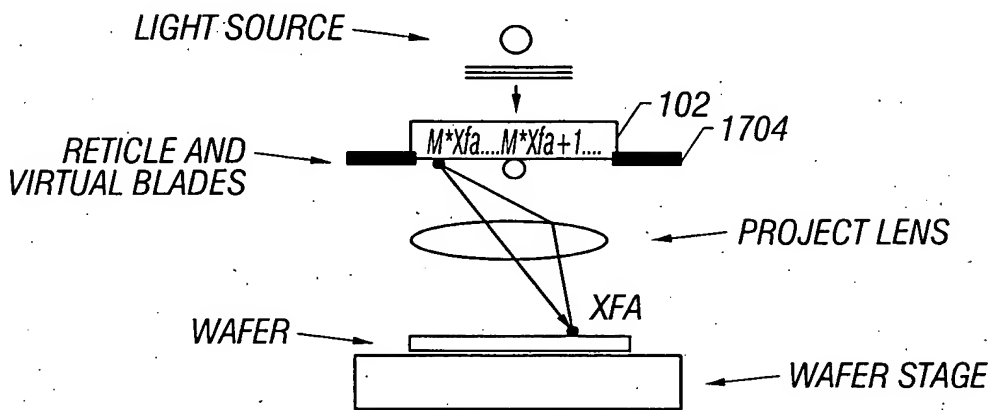


FIG. 17

### Intra-field overlay error

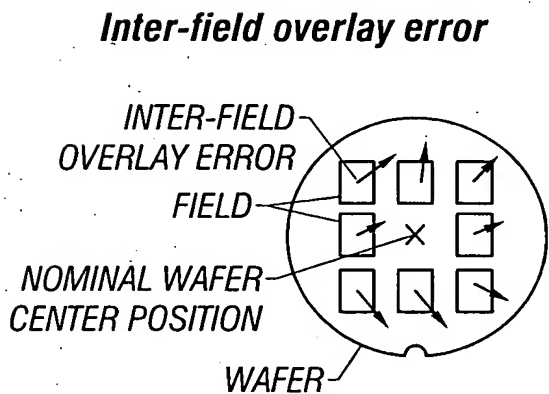


FIG. 18

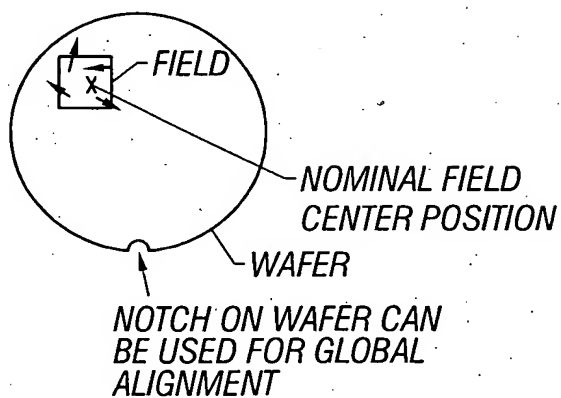


FIG. 19



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Typical Detail of overlay group on New Overlay reticle (FIG. 20) as used on an  $M=4$  lithographic projection tool. Dark=chrome, white=open

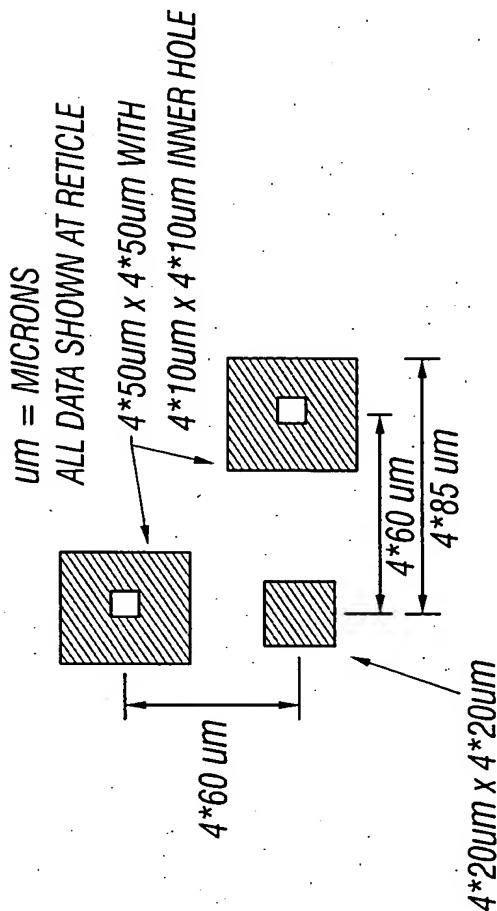


FIG. 20A

New Overlay reticle

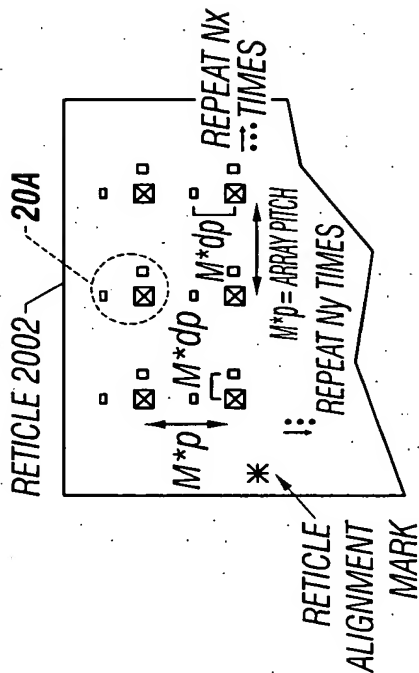


FIG. 20

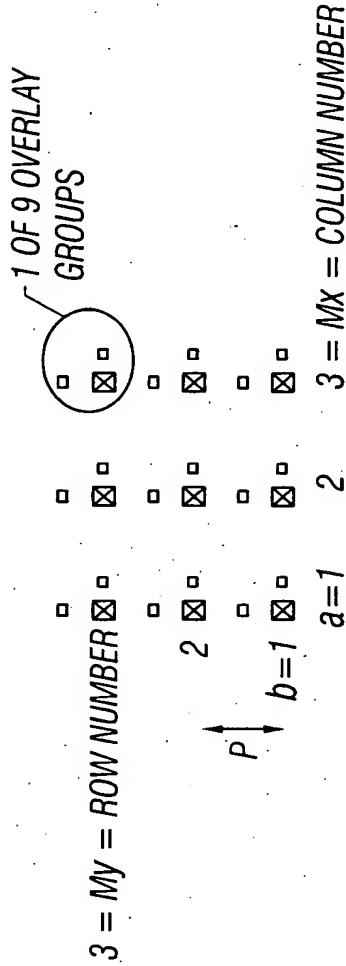
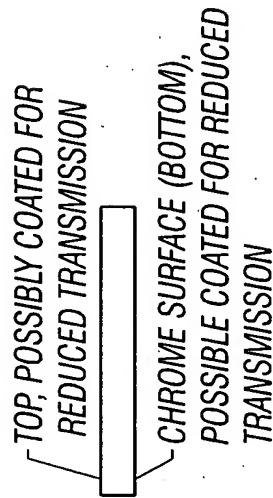




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*Intra-field indices projected onto the wafer*

*Side view of reticle of  
FIG. 20*



**FIG. 20B**

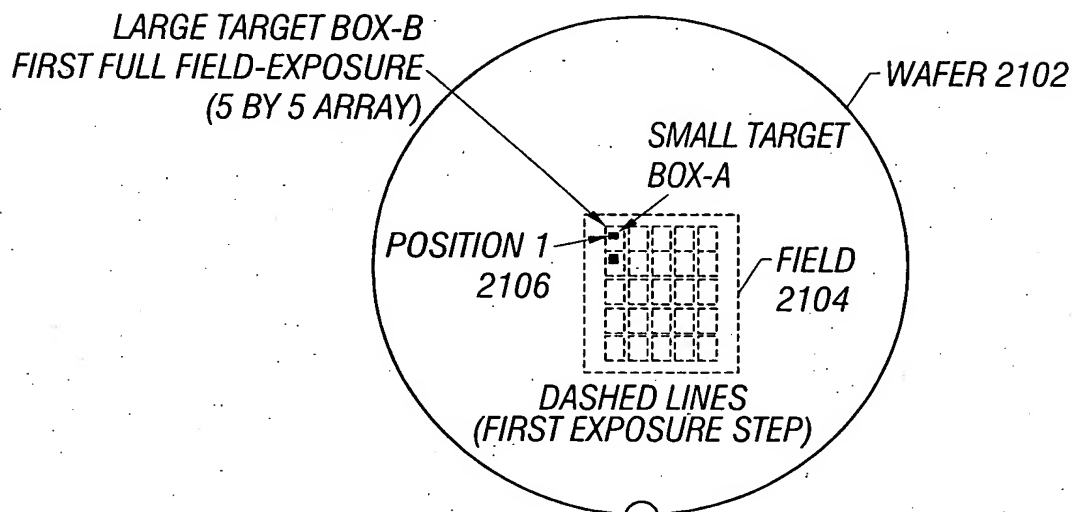
**FIG. 20C**



Heller Ehrman White & McAuliffe LLP  
Title: "METHOD AND APPARATUS FOR SELF-  
REFERENCED PROJECTION LENS DISTORTION  
MAPPING"  
Inventor(s): A. Smith et al.  
Atty Docket No.: 38203-6080C  
Application No.: 10/727,018 - Filed: 12/02/2003

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***Example of prior art lens distortion test***

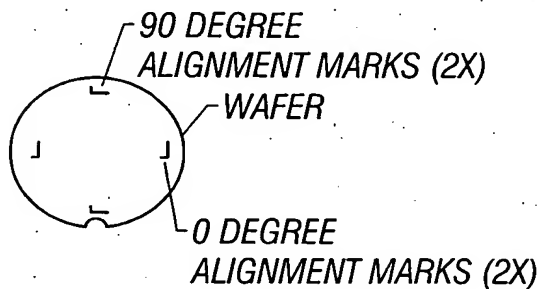


**FIG. 21**  
**(Prior Art)**



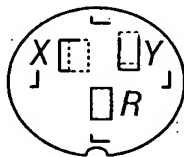
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**Wafer with alignment marks at 0 and 90 degrees**



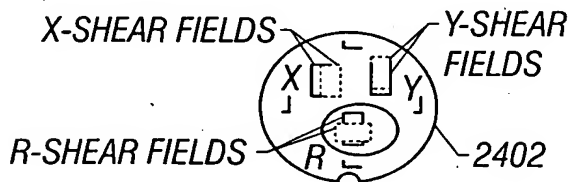
**FIG. 22**

**Wafer after exposure of FIG. 20 overlay  
reticle at the 0 degree orientation**



**FIG. 23**

**Wafer after exposure of FIG. 20 overlay  
reticle at the 0 and 90 degree orientations (clockwise)**

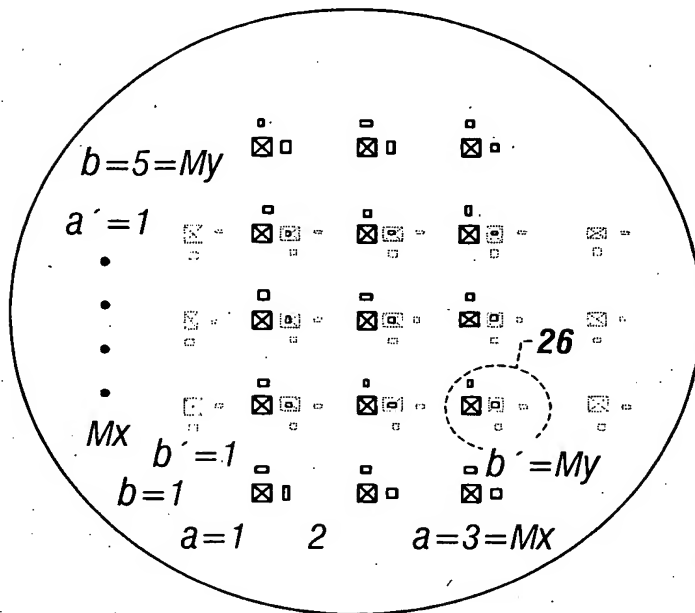


**FIG. 24**



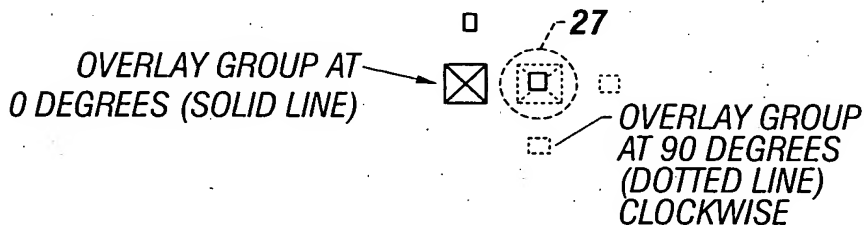
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**Detail of R-shear pattern on wafer**



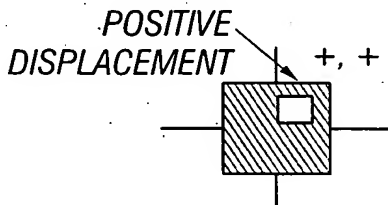
**FIG. 25**

**Closeup of overlay groups for R-shear**

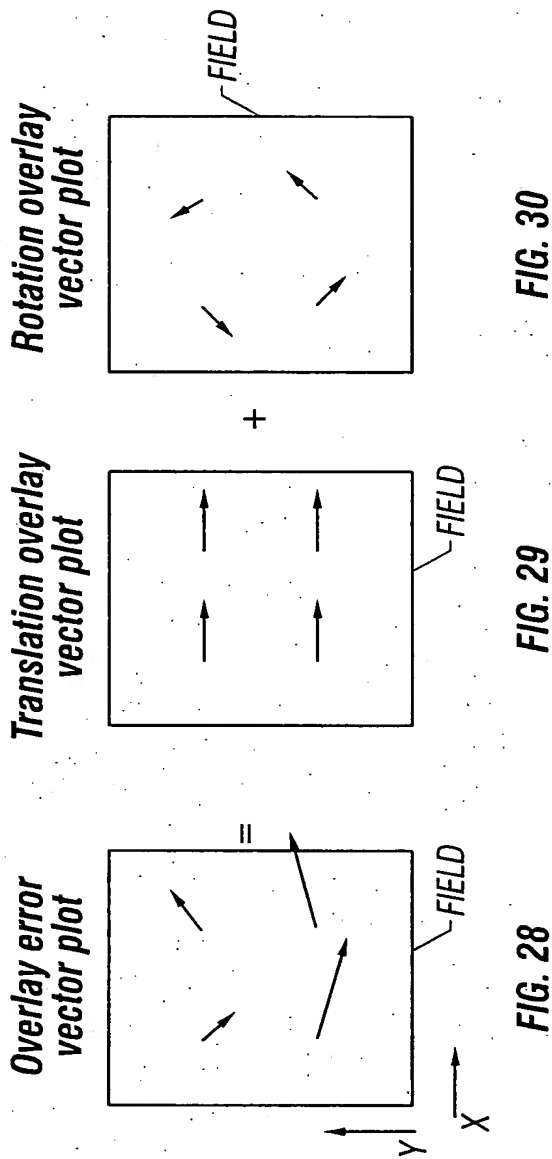


**FIG. 26**

**Single Box-in-Box target.**  
**dark = undeveloped photoresist**  
**white = no photoresist**

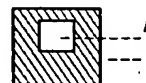


**FIG. 27**



**Overlay measurement**

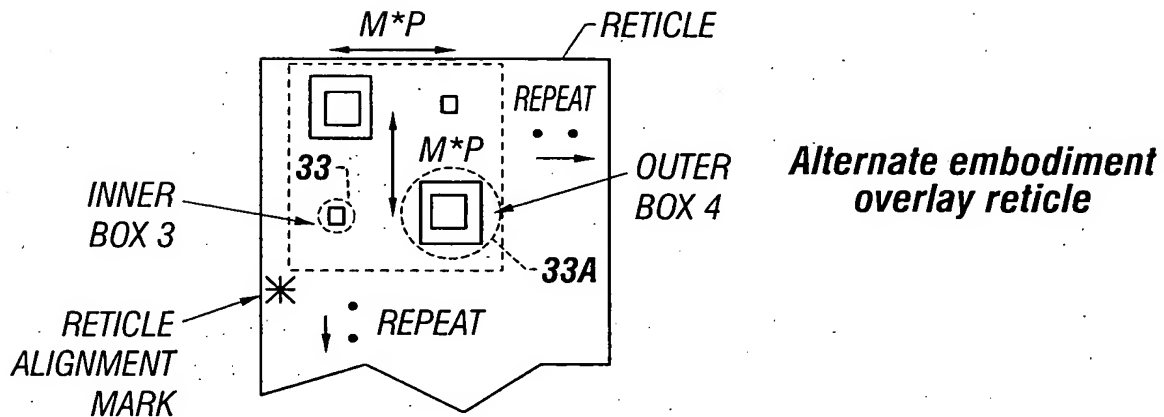
THE VECTOR REPRESENTS THE ALIGNMENT  
 OFFSET DISTANCE BETWEEN THE BOX-IN-BOX  
 STRUCTURE



**FIG. 31**



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*Inner box 3 on reticle.  
Dark=chrome,  
white=open.*

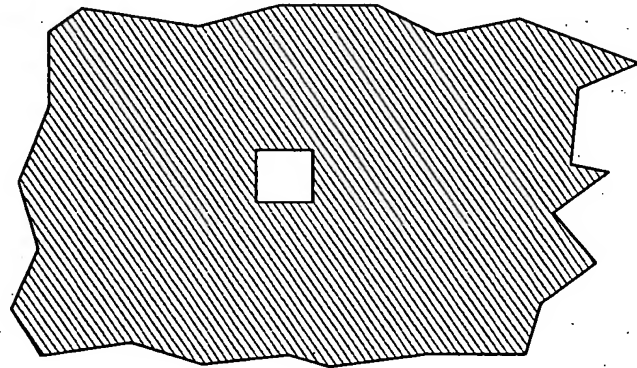


FIG. 33

*Outer box 4 on reticle.  
Dark=chrome,  
white=open.*

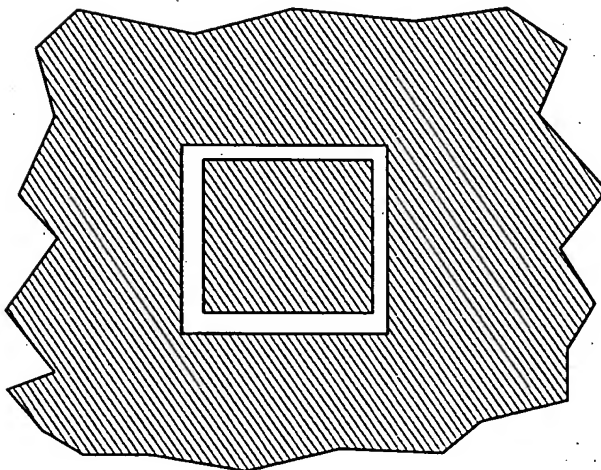
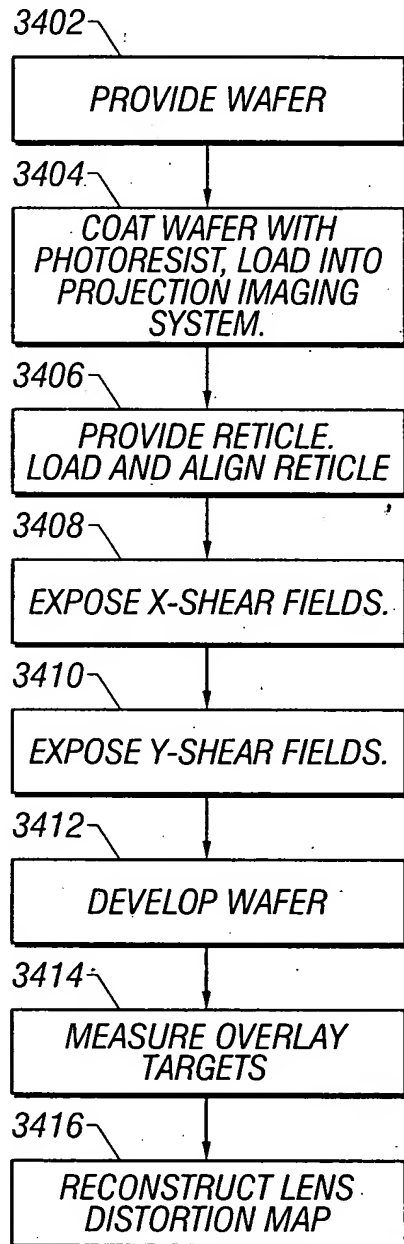


FIG. 33A



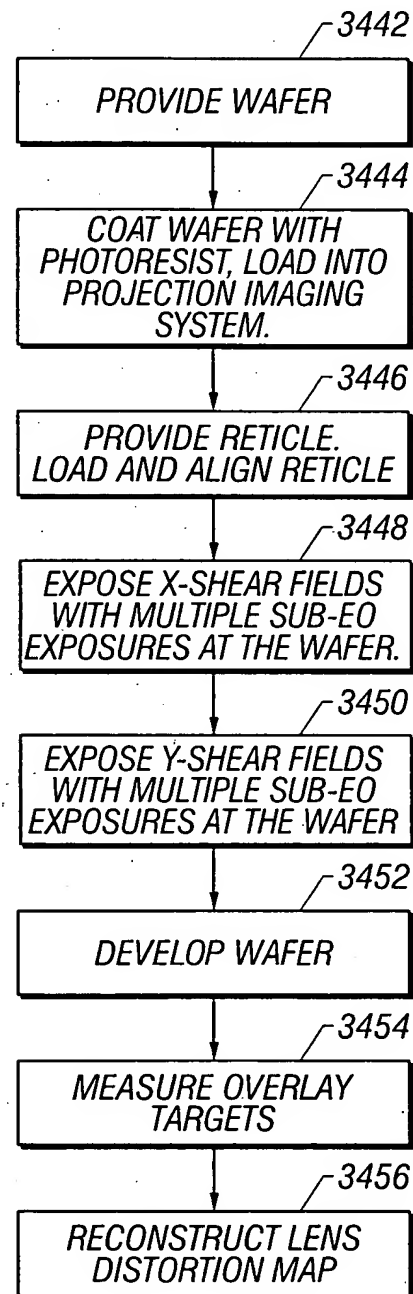
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**Process flow for the preferred  
embodiment for self-referencing  
lens distortion measurement.**



**FIG. 34**

**Process flow for the alternate  
embodiment utilizing sub-Eo  
exposure doses on the wafer.**



**FIG. 34A**



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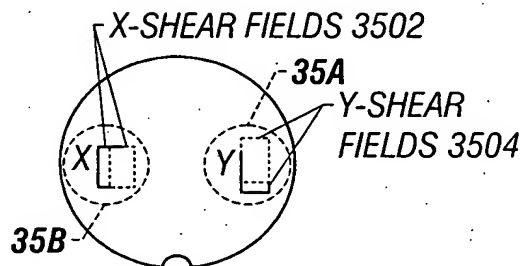


FIG. 35

**Wafer after exposure of  
FIG. 20 overlay reticle for  
X and Y shears.**

**Detail of Y-shear for a 2 x 2  
set of overlay groups**

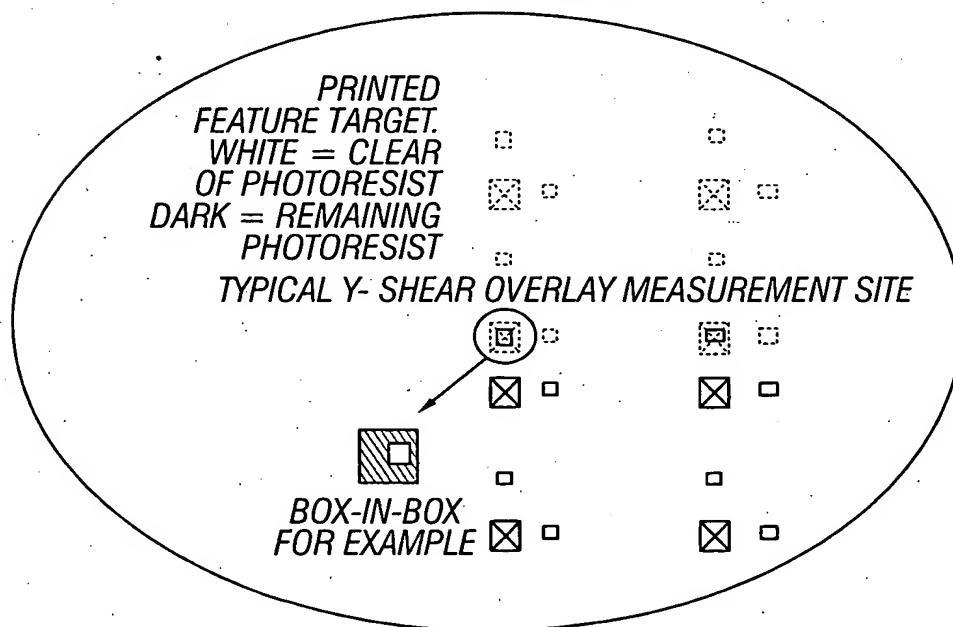


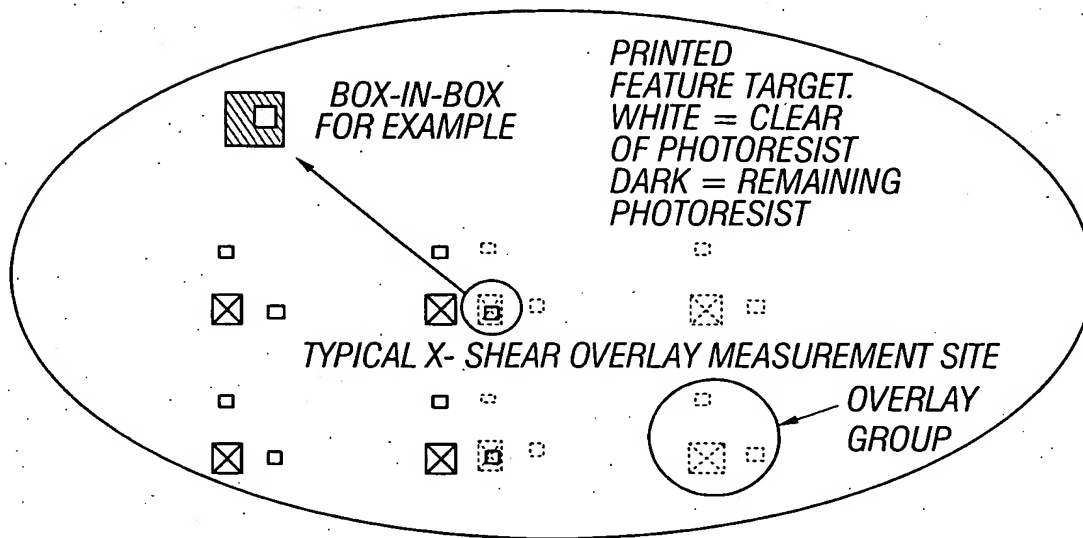
FIG. 35A





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**Detail of X-shear for a 2 x 2  
set of overlay groups.**



**FIG. 35B**

**Final results of the method of this invention.  
Units=microns, (xf, yf) = intra-field location,  
(dxf, dyf) = intra-field distortion at point (xf, yf).**

Machine id: DUVF11-02			
Xf	yf	dxf	dyf
-10000.000	-10000.000	-0.139	0.044
-8000.000	-10000.000	0.223	-0.233
-6000.000	-10000.000	0.498	0.004
.	.	.	.
.	.	.	.
10000.000	10000.000	0.099	-0.188

**FIG. 36**